Conference Paper

Efficiency Estimation of the Bacal Siderites Using to Increase Stability of Steel-Melting Agregates Lining

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Abstract

During the melting processes in steel-melting aggregates, lining destruction takes place due to the Magnesium oxide of lining dissolution in slag. In this study, different materials containing Magnesium oxide have been introduced into slag to increase lining stability. Efficiency estimation of raw siderite (10-0 mm class) using for this aim is considered in the present work. Initial slag (basic capacity CaO/SiO_2=2,1) of industrial ASM (Arc Steel Melting) was corrected by high magnesia introduction additives (siderite). Slag has been loaded into a magnesia crucible, heated up to 1700°C, aged during 1 hour and cooled with the furnace. The final slag phase composition analysis detected considerable changes in it: increase of MeO-phase refractory with MgO prevalence (melting temperature 2800 °C) and replacement of monocellitic silicate component ($CaO·MgO·SiO_2$, melting temperature 1498 °C) by larnite (β-2CaO $·SiO_2$ melting temperature 2130 °C). Crucible slag resistance was estimated by thinning of it walls. Experiment results confirmed affect of MgO content in slag to linings solubility in it. It was determined that siderite additives increase MeO-phase (melting temperature more than 2000 °C) content in slag approximately by 30 % that is rather essential for lining service period increasing. It is confirmed that siderite additives prolongate magnesia lining stability of steel-making aggregates.

Keywords: Bacal siderite, refractory lining, steel-making aggregates, crucible, monocellit, magnesia.

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Siderite reserves in the Southern Urals amount to about 1 billion tons [1]. These ores have a relatively low Iron content (28-33%) and high (8-14%) Magnesium oxide. The only realized currently method for siderite ores processing is blast furnace smelting. The preparation technology realized at Bakal includes raw ore crushing to 60-0 mm class, 10-60 mm class separation and roasting in shaft furnaces. The roasted ore is separated into 60-8 and 8-0 mm classes. The 60-8 mm class is subjected to dry magnetic separation. The concentrate contains 49-50% of Iron at its extraction about 75% [1–4]. The classes of 10-0 mm row ore and 8-0 mm of roasted ore are technology wastes and are subsequently used as an additive in agglomeration processes.

During the melting process in steelmaking aggregates, its linings have been destroyed. This is mainly due to the dissolution of refractory materials in Magnesium oxide slag [5]. To increase the lining stability, various materials containing Magnesium oxide have been added to the slag.

In this paper, we estimated the effectiveness of raw 10–0mm class siderite using for this purpose. The experiments were carried out according to the following procedure. The industrial melting ASM (Arc Steel Melting) of Seversky Tube Plant slag ((%: CaO -5.4; FeO - 32.3; SiO_2 - 16.5; MnO - 6.1; Al_2O_3 - 6.3; MgO - 5.0; S - 0.2) with additive of siderite (%: Fe_{total} - 36.64; FeO - 40.47; CaO - 1.95; SiO_2 - 7.2; MgO - 8.01; Al_2O_3 - 0.99; MnO - 1.83; lost on ignition - 33.4) had been used. This composition have been loaded into magnesite (%: MgO - 78.9; Al_2O_3 - 4.5; CaO -2.2; SiO_2 - 2.8; P_2O_5 - 1.4; C - 10.2) crucible of 100 mm height, 70 mm outer diameter and 14 mm wall thickness. The crucible then was heated to 1700°C during 1 hour and cooled with furnace. The experimental parameters are given in the table. The crucibles were cut along the axis after cooling. Photos of the crucible axial sections are shown in Figure 1. The minimum wall thickness was measured on the sections and slag samples were taken for chemical and phase analysis.

1. Results Test Analysis

The initial slag basicity (CaO/SiO_2 = 2.1) was corrected by high magnesia additives (siderite). In this case, the phase composition of the slag changed significantly. The content of the refractory MeO-phase increased with MgO prevailing in it (melting point 2800°C) and the monicellitic silicate component $CaO \cdot MgO \cdot SiO_2$ (melting point 1498°C) was replaced by larnite β-$2CaO{\cdot}SiO_2$ (melting point 2130°C). Slag resistance was evaluated by the walls thinning of the crucible (fig.2)

Table 1: Experiment parameters

Experiment №	Slag mixture correlation		Crucible wall thickness after experiment, mm.	Experiment temperature, °C
	ASM slag, g	Siderit, g		
1	100	0.0	6	1650
2	100	0.0	5	1700 – 1800
3	0.0	140	13	1700
4	80	64	12.5	1700
5	120	40	10	1700
6	140	20	10	1700

Table 2: Chemical composition of crucible, mass %.

MgO	Al_2O_3	CaO	SiO_2	P_2O_5	C
78.9	4.5	2.2	2.8	1.4	10.2

Table 3: Chemical composition of ASM Seversky Tube Plant slag, %.

CaO	FeO	SiO_2	MnO	Al_2O_3	MgO5,0	S
5.4	32.3	16.5	6.1	6.3	5.0	0.2

Table 4: Chemical composition of row (none roasted siderit), %.

Fe	FeO	CaO	SiO_2	MgO	Al_2O_3	MnO	Lost of ignition
36.64	40.47	1.95	7.2	8.01	0,99	1.83	33.4

1 3 4 5 6

Figure 1: Crucible axial sections. Photos numbers correspond to experiment number.

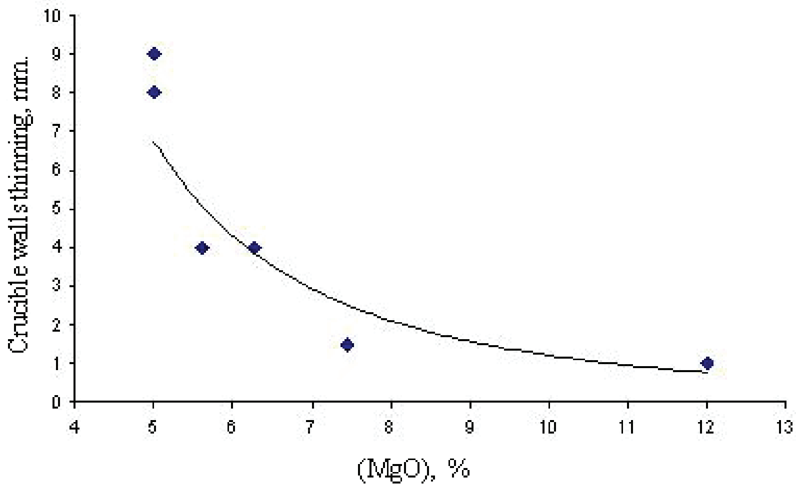

Figure 2: Crucibles slag resistance estimation.

The experimental results confirmed the fact that the more MgO in the slag, the less the lining dissolves [3, 5]. The maximum corrosion of the lining, that is, the crucible wall thickness decrease (table 1, Fig. 2), was registered without MgO addition to the slag – experiments 1 and 2. Lining corrosion decreases, if additional MgO amount is added to the slag. Experiment 3 was carried out with loading siderite only. The final slag contained more than 11% MgO. Minimum corrosion of the lining (1 mm) is obtained in this case. In experiment 4, the proportion of MgO in the slag was increased to 7.5% and close dissolution of the lining (1.5 mm) was obtained. Even a small addition of MgO (content of MgO in the slag is 5.5 and 6.5%) reduces the slag erosion of the lining (experiment 5 and 6) to 4 mm. It was found that when siderite is added, the content of the refractory MeO phase (melting point more than 2000°C) in the slag increases by about 30%, which is very important for the lining service

Thus, laboratory experiments have confirmed the need to increase the MgO content in slag (basicity above 2) from 5 to 11%. Magnesia-containing additives, in the particular case of siderite, can increase the resistance of the magnesia lining of steelmaking units.

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